STATUS OF MINERAL RESOURCE INFORMATION FOR THE PYRAMID LAKE INDIAN RESERVATION, NEVADA

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SUMMARY AND CONCLUSIONS

The commodities of principal interest on the Pyramid Lake Indian Reservation are copper, molybdenum, silver, gold, lead, tungsten, uranium, unconsolidated calcium carbonate (marl), and limestone. Production of metallic minerals has been limited to a small amount of gold, silver, and lead, but occurrences of copper and molybdenum are known and the geologic setting is locally favorable for occurrences of uranium and tungsten. Nonmetallic commodities of potential interest include halloysite clay, sand and gravel, and diatomite. Temperatures as high as 245°F reported in holes drilled at hot springs on the northwest side of Pyramid Lake indicate a potential geothermal resource.

Although the Pyramid, Olinghouse, and Nightingale mining districts adjoin it, there has been essentially no mineral development of related mineralized zones within the reservation. Extensions of these mineralized zones should be especially attractive targets for detailed examination and exploration within the reservation.

Recommended studies include detailed geologic mapping and sampling, with emphasis on hydrothermal alteration and geochemical sampling, possibly followed by trenching and drilling.

INTRODUCTION

Present Investigation and Acknowledgments

This report was prepared for the U.S. Bureau of Indian Affairs by the U.S. Bureau of Mines and the U.S. Geological Survey under an agreement to compile and summarize available information on the geology, mineral resources, and potential for economic development of selected Indian lands. Information sources were published and unpublished reports, as well as personal communications. No field work was done.

Assistance and courtesies received from Robert Donlevy of the Bureau of Indian Affairs, Phoenix, Arizona, are appreciated. Information on past and present reservation leases provided by Hal F. Susie and Moon Hom of the Phoenix District Office of the U.S. Geological Survey, were especially helpful. This information included the private report prepared for American Selco Inc. by John F. Prochnau. Harold F. Bonham of the Nevada Bureau of Mines provided information on recent exploration and geology.

Geography

The Pyramid Lake Reservation covers 475,086 acres, or about 742 square miles (Figure 1). The reservation was created for Paiute and other resident Indians by Executive order in 1874. Several lots in Wadsworth township and several ranches within the reservation are owned in fee by non-Indians.

The reservation includes most of the Lake Range and Terraced Hills, and parts of the Fox Range, Virginia Mountains, Pah Rah Range, and Black Mountain. The southern part of the reservation extends for about 18 miles along the valley of the Truckee River, which empties into Pyramid Lake. Pyramid Lake covers about 180,000 acres (Harris, 1970) in the central portion of the reservation. The valley of Winnemucca Lake lies along part of the eastern boundary, and the valleys of Smoke Creek Desert and San Emidio Desert extend into the northern parts of the area.

The topography of the ranges is moderately rugged, with altitudes ranging from about 4,000 feet at the bases of the ranges to more than 8,000 feet in the Lake Range. Low relief characterizes the valleys and the shoreline areas of Pyramid Lake, the lowest point in the area, which had a surface elevation of 3,792 feet in 1964. The elevation and surface area of the lake are decreasing, however, because annual inflow from the Truckee River and intermittent streams is less than annual outflow (evaporation). From 1919 to 1969, the level of Pyramid Lake dropped about 66 feet. The current imbalance between inflow and outflow is estimated to be about 130,000 acre-feet per year (Van Denburgh and others, 1973). A branch of the Truckee River also supplied water to Winnemucca Lake until the early 1900's, but that lake is now dry.

The average annual precipitation at Nixon is 7.2 inches, most of which comes from winter storms. The precipitation probably is significantly greater in the higher parts of the ranges.

The reservation is within the area covered by the Reno and Lovelock topographic maps published at a scale of 1:250,000. More detailed topographic maps at scales of 1:62,500 or 1:24,000 are available for all except the northwest corner of the reservation.

State Highways 33 and 34 are along the west and east sides of the reservation, respectively, and join Interstate 80, a major east-west highway. Commercial transportation is available in Reno, 40 miles to the southwest. The small towns of Nixon, Sutcliffe, and Wadsworth are within the reservation, with tribal headquarters at Nixon. The Indian population residing on, or adjacent to, the reservation is about 414.

Previous Investigations

The geology of the area was first described in the reports on the exploration of the Fortieth Parallel (Hague and Emmons, 1877; King, 1878). Physiographic features related to Pyramid Lake and Winnemucca Lake were described by Russell (1885) during his studies of Lake Lahontan, and the lacustrine and subaerial units were studied in detail by Morrison and Frye (1965). The geology in the vicinity of Mullen Pass has been described by McJannet (1957) and Wallace (1976). The most comprehensive source of information on the geology of the Pyramid Lake Indian Reservation is the report by Bonham (1969) on the geology and mineral deposits of Washoe and Storey Counties. The water resources of the area have been studied by Van Denburgh, Lamke, and Hughes (1973).

GEOLOGY

General

The Pyramid Lake Indian Reservation is in the western part of the Basin and Range physiographic province, which is characterized by block-faulted mountain ranges with intervening alluvial-covered valleys, commonly with interior drainage. The rocks in the mountains are mainly sedimentary and volcanic rocks of Triassic to Tertiary age that are locally intruded by stocks and smaller intrusive bodies of Jurassic to Tertiary age (Figure 2). The oldest rocks exposed are metamorphosed sedimentary rocks of probable Triassic and Jurassic age. The overlying rocks, which form the major portions of the ranges, are predominantly of volcanic origin, but they also contain intercalated sedimentary rocks. The older volcanic rocks include basaltic to rhyolitic flows, tuffs, and breccias; extensive basalt flows comprise the younger volcanic rocks. The deposits in the valleys include lacustrine and alluvial deposits of Tertiary and Quaternary age. The Mesozoic sedimentary rocks are faulted, folded, and regionally metamorphosed. Faulting which defines the mountain ranges and structural valleys began in late Tertiary time and has continued intermittently to the present. The metallic ore deposits in the region are closely related to intrusion of igneous rocks.

Rock Units

Mesozoic rocks

Triassic and Jurassic metasedimentary rocks

Metamorphosed sedimentary rocks of probable Triassic and Jurassic age are exposed in the Fox Range and at Marble Bluff. The age of these rocks is uncertain because of a scarcity of fossils and the lack of definitive stratigraphic relations with underlying and overlying formations. In the Fox Range the metasedimentary rocks are composed of several thousand feet of dark-gray to black argillite and slate, gray phyllite, impure quartzite, and some interbeds and lenses of limestone and dolomite. The clastic rocks adjacent to granodiorite intrusive bodies are further metamorphosed to schist, hornfels, and gneiss, and the carbonate rocks are metamorphosed to skarn or calc-silicate hornfels.

Recrystallized gray to white limestone and dolomite is exposed in an area of about 2 square miles at Marble Bluff. The carbonate rocks are surrounded by lacustrine deposits and are partly covered by calcareous tufa on the lower slopes of the hills. The massive, finely crystalline carbonate rocks are at least several hundred feet thick. Stephenson (1966) reports that the large blocks of limestone are separated from the dolomite by normal faults. The limestone, which is uniform in quality and is low in magnesia and alkali, has been quarried for the manufacture of cement.

Intrusive Rocks

Intrusive rocks of Jurassic or Cretaceous age are exposed in the Fox Range, where they intrude the metasedimentary rocks and are overlain unconformably by Tertiary volcanic and sedimentary rocks. The only other exposure of these intrusive rocks within the reservation is along the east shore of Pyramid Lake, about 1mile north of Pyramid Island, where the outcrops are bordered by Quaternary lake deposits.

Granodiorite is the most abundant rock type, but the composition of the intrusive bodies may range from quartz monzonite to quartz diorite. Fine-grained quartz diorite is locally developed along the margins, and isolated pendants of gabbro occur in some places. The typical granodiorite contains biotite, hornblende, andesine, quartz, and alkali feldspar. Sphene, zircon, and opaque minerals are accessory minerals. Most of the granodiorite has a porphyritic texture, with phenocrysts of biotite, hornblende, and plagioclase in a fine- to medium-grained groundmass of quartz and alkali feldspar, but in some places the texture is equigranular.

The exact age of the granodiorite intrusive rocks is not known. No age determinations have been made on these rocks in the Pyramid Lake Indian Reservation or in adjacent ranges, but other granitic plutons in western Nevada that probably were emplaced during the same time of plutonic activity have potassium-argon ages that range from Jurassic to Late Cretaceous (Schilling, 1965).

Tertiary rocks

Hartford Hill Rhyolite Tuff

The Hartford Hill Rhyolite Tuff, of early Miocene age, crops out in the Virginia Mountains and the Pah Rah Range. These exposures are near the northern limits of the formation, which was distributed over an area of several thousand square miles in western Nevada. The formation is as much as 4,000 feet thick near Mullen Pass. About 3 miles south of Pyramid Lake, the Hartford Hill Rhyolite Tuff unconformably overlies volcanic breccia of Oligocene(?) age (Bonham, 1969), but elsewhere in western Nevada, it overlies metamorphic and granitic rocks of Mesozoic age.

The Hartford Hill Rhyolite Tuff is composed of light-pink to purple welded ash-flow tuffs that range from rhyolite to quartz latite. Phenocrysts comprise as much as 40 percent of the rock in some cooling units, but in others phenocrysts are rare. The phenocrysts, which consist of quartz, sanidine, oligoclase, and biotite, are in a groundmass of devitrified glass shards and collapsed pumice fragments. Some thin lenses of arkosic sandstone, conglomerate, and volcanic breccia are intercalated in the ash-flow tuffs.

Potassium-argon ages on the Hartford Hill Rhyoiite Tuff range from 22.5 to 22.8 m.y. (Evernden and James, 1964; Whitebread, 1976) and establish the age of the formation as early Miocene.

Quartz Monzonite

Quartz monzonite of Miocene age is exposed in an area of more than a square mile in the Pah Rah Range near the south end of Pyramid Lake. The quartz monzonite intrudes the Hartford Hill Rhyolite Tuff and locally is overlain by the Chloropagus Formation of the Pyramid sequence. The intrusive body is composed of medium-grained quartz monzonite in the central part, but it becomes porphyritic along the outer margins. The quartz monzonite consists mainly of quartz, microcline, plagioclase, and biotite, but it has been weakly to intensely altered. The hydrothermal alteration ranges from the propylitic type in the central part to quartz-sericite alteration in the outer parts of the stock. The more intensely altered parts also have been bleached to shallow depths by sulfuric acid produced by oxidation of pyrite. The quartz monzonite is the host rock at the Guanomi mine, where molybdenite occurs with pyrite as disseminations and in veinlets, and as much as 0.10 percent copper is reported in the rock.

Intrusive bodies in several small exposures in the Mullen Pass area were previously assigned to the Kate Peak Formation, but now are believed to be older than that formation (H. F. Bonham, oral commun., 1976). Emplacement of these quartz diorite intrusive bodies is related to a northeast-trending structural lineament (Bonham, 1969).

An intrusive body of diorite porphyry too small to show on the geologic map is reported by Bonham (1969) in the Lake Range. The diorite porphyry cuts the andesite and basalt flows of the Pyramid sequence. It consists of phenocrysts of labradorite and pyroxene in a fine-grained groundmass of plagioclase, pyroxene, magnetite, apatite, and quartz. The rock has been weakly propylitized.

Pyramid Sequence

The Pyramid sequence was named by Bonham (1969) to include an extensive section of volcanic and sedimentary rocks of mostly late Miocene age that are typically exposed in the ranges around Pyramid Lake. The Pyramid sequence consists of basalt and andesite flows, flow breccias, and mudflow breccias, with intercalated diatomite, shale, rhyolitic tuff and tuff breccia, and dacite welded tuff. The sequence unconformably overlies the Hartford Hill Rhyolite Tuff.

The lower part of the Pyramid sequence in the Mullen Pass area was named the Pyramid Formation by McJannet (1957). It consists of about 1,200 feet of basalt flows, mudflow breccias, and well-stratified lapilli tuffs, with some lenses of diatomite and shale. The Chloropagus Formation, which unconformably overlies the Pyramid Formation of McJannet, crops out in the Virginia Mountains and the Pah Rah Range. It is composed of more than 3,000 feet of flows, flow breccias, and mudflow breccias of olivine basalt and pyroxene andesite with intercalated rhyolitic to rhyodacitic tuff and lenses of dark shale and coarse-grained sandstone. Diatomite, shale, and tuffaceous sandstone are interbedded in some of the tuffs. Widely exposed intermediate to mafic volcanic rocks assigned to the Pyramid sequence in the Lake Range, Fox Range, and northern part of the Virginia Mountains are correlative in part with the Chloropagus Formation. In the Lake Range, the Pyramid sequence is more than 2,000 feet thick and is composed of basaltic, andesitic, and dacitic flows, andesitic to dacitic tuff and tuff breccia, dacitic welded ash-flow tuff, and intrusive bodies.

The rocks of the Pyramid sequence range in age from middle or late Miocene to early Pliocene. Bonham (1969) reports a potassium-argon isotopic age of 15.2 m.y. from a basalt flow in the Pyramid Formation of McJannet near Mullen Pass, and Evernden and James (1964) determined a potassium-argon age of 12.4 m.y. from dacite welded ash-flow tuff that unconformably overlies the basalt flow.

Basalt

Olivine basalt flows and associated intrusive rocks of late Miocene and Pliocene age are exposed in the southern Fox Range, Terraced Hills, Lake Range, and on Black Mountain. Individual flows are generally 10 to 20 feet thick and are vesicular near their tops.

The flows in the Fox Range and Terraced Hills are part of a regionally extensive pile of basalt extruded from numerous fissures and local vents in western Nevada and adjacent parts of California and Oregon. The basalt is most commonly dark gray, holocrystalline, equigranular rock containing labradorite, olivine, augite, and accessory apatite and opaque minerals.

Olivine basalt flows of middle to upper Pliocene age in the Lake Range and on Black Mountain appear to be of more local extent. These basalts typically have a porphyritic texture, with small phenocrysts of olivine and plagioclase in a matrix of olivine, augite, plagioclase, and opaque minerals. They are more than 1,000 feet thick in the Lake Range, where they overlie rocks of the Pyramid sequence.

Rhyolite

Two small plugs or domes of rhyolite in the Fox Range are bisected by the northern boundary of the Pyramid Lake Indian Reservation. The rhyolite intrudes the Mesozoic metasedimentary rocks and the Pyramid sequence. The rhyolite is various shades of gray and contains sparse phenocrysts of plagioclase, sanidine, and biotite in a partly devitrified groundmass. Some of the rhyolite is highly flow banded, and in places perlite or pumice are developed. The rhyolite bodies have been correlated with the Washington Hill Rhyolite Tuff of Pliocene age in the Virginia Range.

Quaternary Deposits

Lacustrine Deposits

Pleistocene lacustrine sediments deposited in Lake Lahontan are present in the Smoke Creek and San Emidio Deserts, the valleys of Pyramid and Winnemucca Lakes, and in the Truckee River valley. Holocene lacustrine deposits also are present in the valleys of Pyramid and Winnemucca Lakes. The lake sediments consist mainly of clay, silt, and sand; sand and gravel are common along the margins of the old lake basins, where shoreline features of Lake Lahontan are locally well preserved. Tufa deposits are especially well developed along the shorelines of Pyramid Lake, which is a remnant of Lake Lahontan.

Surficial Deposits

Unconsolidated surficial deposits that occur within the reservation include stream sediments, fanglomerates, landslides, and eolian sands. The stream sediments are most extensive along the Truckee River, and the fanglomerates occur near the range fronts. The largest landslide is in the Pah Rah Range near the southern end of Pyramid Lake, but smaller landslides have been recognized in the Lake Range. The surficial deposits range in age from Pleistocene to Molocene and include some pre-Lahontan deposits.

Structure

The rocks exposed in the Pyramid Lake Indian Reservation record two main episodes of structural deformation. The older episode occurred in late Mesozoic time; the second episode began in the middle to late Tertiary and has continued to the present time.

During the late Mesozoic deformation, the Triassic and Jurassic sedimentary rocks were folded, faulted, regionally metamorphosed, and then intruded by granitic rocks. Details of the structural geology of these pre-Tertiary rocks are poorly known because of their limited exposures in the region.

During the late Tertiary and Quaternary deformation, the present outline of the mountain ranges and valleys was formed by faulting, tilting, and minor folding. The Fox and Lake Ranges are typical of north-trending block-faulted ranges of the Basin and Range province. These two ranges, which are bounded on the west by a north- to northwest-trending high-angle fault, are tilted eastward, as shown by Tertiary rocks within the ranges that now dip as much as 30° to the east. Northwest- and northeast-trending faults within the Fox and Lake Ranges are high-angle normal faults.

The northwest trend of the Virginia Mountains and Pah Rah Range is controlled by faults within the Walker Lane, a northwest-trending zone of topographic and structural discordance that extends for several hundred miles (Ferguson and Muller, 1949; Neilson, 1965; Albers, 1967). Northwest- and northeast- trending faults in the Terraced Hills and in the portions of the Virginia Mountains and Pah Rah Range within the reservation are high-angle normal faults with dip-slip movement. Bonham (1969), however, has described oblique-slip faults in the Pah Rah Range that he believes are near-surface manifestations of the major right-lateral wrench faulting of the Walker Lane. South of Nixon, northwest-trending faults of the Walker Lane cut Pleistocene gravels but do not offset younger sediments.

Metamorphism

The effects of both regional and contact metamorphism can be observed in the rocks exposed in the reservation. Regional metamorphism of the Triassic and Jurassic sedimentary rocks, which converted the argillaceous sediments to argillite and phyllite and caused recrystallization of the limestone, probably is related to Mesozoic deformation of the Sierra Nevada region (Thompson, 1956). Contact metamorphism, which produced marked changes in some rocks around the margins of intrusive bodies, was most pronounced in the Fox Range, where Mesozoic metasedimentary rocks adjacent to granodiorite bodies were mainly converted to schist, hornfels, and gneiss.

Hydrothermal Alteration

Two types of hydrothermal alteration have been recognized in the rocks within the Pyramid Lake Indian Reservation. Weak propylitic alteration is relatively common in the mafic volcanic rocks of the Pyramid sequence and in the Hartford Hill Rhyolite Tuff, and more intense propylitic alteration has been noted in the Olinghouse and Pyramid mining districts adjacent to the reservation (Bonham, 1969). Quartz-sericite alteration near the margins of the quartz monzonite intrusive body near the south end of Pyramid Lake grades into propylitic alteration in the central part.

Quartz-sericite-pyrite alteration is common adjacent to veins cutting the Hartford Hill Rhyolite Tuff in the Pyramid district.

The association between hydrothermally altered rocks and mineral deposits is well established, and alteration is widely used as a guide in the exploration for ore deposits.

MINERAL RESOURCES

General

The area immediately surrounding the Pyramid Lake Indian Reservation contains several productive mining districts, including the Cottonwood district in the Fox Range, the Nightingale district in the Truckee Range, the Olinghouse district in the Pah Rah Range, and the Pyramid district (Figure 3). Ores containing silver, gold, tungsten, uranium, copper, lead, zinc, molybdenum, and antimony have been mined in these districts. The ore minerals occur mainly in veins and fractures or as contact pyrometasomatic deposits.

Within the reservation, production of metallic minerals has been small. Some lead, silver, and gold was shipped from the Packard mine in the Fox Range and a small amount o£ gold and silver probably was produced from the Guanomi mine near the south end of Pyramid Lake; molybdenum and copper occur in the mine area. Silver is reported at the Lakeview prospect in the Lake Range, but no ore has been shipped. The ore at the Packard and Lakeview properties occurs in veins, but the disseminated occurrences of molybdenum and cupriferous pyrite in the Guanomi mine area suggests that the deposit is of the porphyry type

The principal nonmetallic commodities produced within the area of the reservation are limestone, unconsolidated calcium carbonate (marl), and sand and gravel; halloysite, diatomite, and perlite also have been mined in nearby areas.

Metallic Mineral Deposits

General

Unlike much of the public domain in Nevada, the Pyramid Lake Reservation was never subjected to intensive mineral prospecting. Not only was the reservation established early (1874), but prior to that action, the Indians resisted the intrusion of prospectors into their area.

Joining the reservation on its west side are the Pyramid and Olinghouse mining districts, and their mineralized formations continue eastwardly. However, within the reservation, these formations are yet to be developed. Hill (1911, pp. 99-106), Overton (1947), and Bonham (1969) discuss these mining districts in detail. Silver, gold, lead, copper, tungsten, and uranium, amounting to more than a million dollars, have been shipped from the two districts.

The Nightingale mining district lies along the boundary between Pershing and Washoe Counties, which is several miles east of the reservation. This district is separated from the reservation by the alluvium-filled Winnemucca Lake valley, and consequently, the district's geologic formations cannot be directly traced onto the reservation. However, formations similar to those in the district occur on the reservation. The Nightingale district has produced over 100,000 short-ton units of tungsten (Bonham, 1969, p. 70).

The presence of these districts and the Cottonwood mining district on the north boundary indicate that the reservation is within a mineralized region.

Antimony

Lawrence (1963, p. 223) describes the Ross prospect at the southern end of the Fox Mountains in sections 5 and 8, T. 28 N., R. 21 E. He thought that it might be part of the Sano Consolidated prospect; however, recent topographic maps show the location to be west of the Sano. He mentions that "No antimony ore has been produced. Only very small amounts of tetrahedrite and stibnite are present. "He did not visit the property and gives no source for his information.

Copper-molybdenum

Guanomi Mine

History.--The Guanomi mine is on the southwest shore of Pyramid Lake in the SW ¼ sec. 24, T. 23 N., R. 22 E. The property was developed in the 1920's for gold and silver (Bonham, 1969, p. 96-97). Later it was explored for copper and molybdenum. Apparently the initial discovery was made in a cut during the construction of a section of the Southern Pacific Railway. The line was abandoned and track removed in 1971. T. W. Foster drilled several holes near the railroad cut; a four-foot intercept between 155 to 159 feet in a drill hole (No. 2) reportedly assayed 1.08 ounces gold per ton. This find led to the sinking of a 135-foot-deep shaft during the 1930's. In 1938, an adit was started about 100 feet south of the shaft and trended westward beneath the railway cut. Walter H. Schmelezer worked the adit over a period of years. It was driven 450 feet westwardly with two headings, one about 80 feet in length and the other 450 feet in length driven in a southerly direction. It was abandoned in 1958.

Geology.--The Guanomi mine is in a small area of highly altered Tertiary quartz monzonite porphyry surrounded by Pleistocene lacustrine deposits. Minor molybdenite occurs in quartz veinlets and fractures and less commonly as disseminated grains in the intrusive rock. Pyrite is abundant as disseminations and in veinlets. The pyrite probably is cupriferous, because as much as 0.10 percent copper is reported in the intrusive rock (Bonham, 1969).

The intrusive body is more widely exposed about one-half mile west of the mine, where it covers an area of about 1 square mile. The quartz monzonite has been weakly to intensely altered, with propylitic alteration common in the central part of the intrusive and quartz-sericite alteration in the outer parts. Alteration in the Hartford Hill Rhyolite Tuff intruded by the quartz monzonite also ranges from propylitic to quartz-sericite alteration. More intensely altered parts of the intrusive that contained abundant pyrite have been further altered and bleached to shallow depths by sulfuric acid produced during oxidation of the pyrite.

A breccia zone locally more than 300 feet wide can be traced for more than 1,000 feet in the quartz monzonite along its southern contact with the

Hartford Hill Rhyolite Tuff. Abundant iron oxides in outcrops of the breccia indicate the former presence of sulfides.

Recent Exploration.--In 1971, American Selco, Inc. acquired a 2,500-acre lease and explored the property. The lease area was geologically mapped and geochemically and geophysically surveyed, followed by 5,230 feet of rotary and diamond drilling in 9 holes. The following information is summarized from a private report prepared by John Prochnau for American Selco, Inc., 1973.

Within the intrusive, mineralization was confined to silicified ribs marking fault traces and to a weakly silicified and potassium-metasomatized quartz monzonite phase along the northwest margin of the stock. Traces of libethenite, an emerald green phosphate of copper, and malachite occur in these rocks producing anomalous geochemical copper values in that portion of the stock.

A geochemical soil survey was made of the lease area. Samples were tested for copper, lead, zinc, and molybdenum. Copper and molybdenum levels were not high, but anomalous values (100 ppm copper and 8 ppm molybdenum) were found peripheral to the Guanomi stock and generally coincident with the area of most intense alteration in the Hartford rhyolite. Lead and zinc levels were generally low, although several one- or two-station highs coincided with copper anomalies. Zinc appeared to be concentrated in the sediments of Tom Anderson Canyon.

An induced polarization (IP) survey was made by McPhar Geophysics of Tucson over part of the lease area. Weak IP responses were noted over areas containing disseminated sulfide minerals along the east margin of the Guanomi stock. The IP survey did not outline any targets indicative of a large porphyry-type deposit.

Mercury vapor surveys showed consistently low mercury levels (1-2 ppb), but serious problems of reproducibility were noted. However, one survey defined a northeast-trending anomalous zone, with values of 5 to 10 times background, southeast of the Guanomi mine. This anomaly was not tested.

A ground magnetic survey was completed, using a nuclear precession magnetometer. The most distinctive magnetic anomaly was an irregular pattern characterized by abrupt polarity reversals, west of the Guanomi mine area. A second anomaly, 200 to 300 gammas above background, follows the shoreline of Pyramid Lake along the north edge of the lease area. This was interpreted by Prochnau (1973, p. 8) as representing black sand accumulations along the beach at the mouth of the Truckee River. A weak, northeast-trending, magnetic linear through the Guanomi mine area is crudely correlative with IP (induced polarization) data.

During the autumn of 1971, six holes, averaging 200 feet in depth, were rotary drilled in the Guanomi mine area to investigate IP results. All drilling intercepted silicified Hartford rhyolite which had 3 to 5 percent disseminated pyrite and anomalous metal values. In 1973, hole No. 5 was deepened to 1,000 feet, and holes Nos. 7, 8, and 9 were extended to depths of 860, 740, and 1,625 feet, respectively. For locations and graphic sections of these holes, with analyses, see Figure 4, Figure 5, Figure 6, and Figure 7. Following are brief logs of holes 5, 7, 8, and 9 (Prochnau, 1973):

Hole PRH #5 (Figure 5) Silicified and pyritized Hartford Hill volcanics, similar to rock on the mine dumps, were intercepted throughout the length of the hole and had average metal values of 0.047 percent copper and 0.0021 percent molybdenum. Copper content decreased gradually downhole from 0.067 percent in the upper 100 feet to 0.036 percent in the bottom 100 feet, while molybdenum values increased slightly from 0.0013 percent to 0.0024 percent over the same intervals. Tungsten and fluorine contents, considered tracer elements for molybdenum mineralization, remain at background levels.

Hole PRH #7 (Figure 6) was designed to test the copper- anomalous silicified phase of quartz monzonite along the northwest margin of the Guanomi stock. Although planned to reach a depth of 1,000 feet, it was abandoned at 860 feet after the hole repeatedly caved. It was collared in the post-mineral Chloropagus Formation, then from 180 to 210 feet it penetrated weakly pyritized Hartford Hill rhyolite, before entering the silicified quartz monzonite. Metal content for the interval between 210 and 350 feet averaged 0.067 percent copper and 0.0030 percent molybdenum. Beyond 350 feet, the quartz monzonite was considerably less altered and contained lower metal values.

Hole PRH #8 (Figure 6), which is at the south contact of the Guanomi stock, intercepted anomalous molybdenum values in Hartford Hill volcanics. Target depth was 1,000 feet, but difficult penetration forced abandonment at 740 feet. Pyritized and silicified volcanic rocks were intercepted to a depth of 500 feet, beyond which the hole entered relatively fresh quartz monzonite. Metal values averaged 0.020 percent copper, and 0.0032 percent molybdenum, with only minor variations, to the bottom of the hole.

Hole PRH #9 (Figure 5) was planned as a deep test in the core of the Guanomi stock. The purpose was to check the "multiple shell" model characteristic of porphyry molybdenum deposits. The hole was hammered to 525 feet, at which point it became necessary to core. Because of increased caving and absence of significantly increased alteration, it was terminated at a depth of 1,625 feet. The hole remained in quartz monzonite for its entire length. Except for occasional sections of weak argillic alteration, the rocks were fresh and unaltered. Anomalous molybdenum values were restricted to narrow quartz-feldspar or gypsum veinlets at shallow angles to the core axis. There was no evidence the core was approaching significant mineralization.

Following American Selco's drill program, the U.S. Geological Survey, under the direction of Dr. John Sass of Menlo Park, conducted depth-temperature studies in drill hole No. 9.

Results of American Selco's surveys, and drill tests, confirm the presence of copper and molybdenum in altered and pyritized rocks peripheral to the Guanomi stock. Metal values averaging about 0.05 percent copper and 0.003 percent molybdenum are remarkably consistent over a widespread area. However, there are no indications of economically significant mineral values.

Silver-lead

Lakeview Mine

The Lakeview mine, on the east side of Pyramid Lake about ½ mile from the shoreline and about 1,000 feet above the lake level (Figure 3), is in the NE ¼ sec. 14, T. 25 N., R. 22 E.

Initial development was in the late 1920's, while the Lakeview was under lease to Fred Eckley and Fred A. Anderson of Nixon, Nevada. Workings consisted of a 100-foot-deep shaft and 100 feet of drifting on several levels. The shaft exposed silver-lead ore as a replacement along the contact zone between rhyolite and andesite. The contact zone strikes N. 45° E., dips vertically, and is 6 to 7 feet wide. The ore was from a zone ½ to 2 feet wide. The rock intersected in the upper 75 feet of the shaft was oxidized; galena and other sulfides were found in the rock below.

One 45 ton carload of hand-picked ore was shipped in 1929(?) to the smelter at Shelby, California; it contained:

Gold	0.06 ounce per ton
Silver	36.0 ounces per ton
Lead	13.6 percent
Iron	18.3 percent
Zinc	0.0 percent
Sulfur	5.1 percent

This shipment apparently exhausted the available high-grade ore in the shaft workings. In 1930, Alfred E. Freeman acquired the Eckley-Anderson lease and commenced a crosscut 1,800 feet northwest of, and 800 feet lower than, the discovery shaft on the Lakeview (Figure 8). The purpose of the crosscut was to cut the Lakeview and other parallel structures at depth. By May 1931, it was about 590 feet long. The leases lapsed shortly thereafter. A mineralized contact containing quartz, pyrite, and galena in a zone from 4 to 12 inches wide was encountered 308 feet from the portal (Figure 8). At 406 feet there is a streak of galena and quartz 1 inch thick. At 527 feet, there is a vein of quartz, galena, and sphalerite 1 to 3 feet wide.

In 1945, the Ashdown Mining Company applied for a lease on the Lakeview claim. It is not known if a lease was granted or that any work was performed.

Packard Mine

The Packard mine, about 5 miles north of Pyramid Lake and 4 miles southeast of Sano, is in the N ½ sec. 9, T. 28 N., R. 21 E.

The property was developed in the early 1920's by the Ambassador Mines Co. of Reno, Nevada. By 1929 they had driven a 495-foot adit that had three crosscuts whose lengths totaled 95 feet (see Figure 9). The main ore body was intersected in the adit at the first crosscut and extended 130 feet to the second and third crosscuts. File data (U.S. Geological Survey, Phoenix) do not describe the mineralized zone. However, 5,810 pounds of hand-sorted lead-silver ore was shipped to American Smelting and Refining Co.'s smelter at Shelby, California, and assayed:

Gold	0.135 ounce per ton
Silver	38.10 ounces per ton
Lead	22.3 percent
Zinc	4.3 percent
Sulfur	12.6 percent
Iron	12.1 percent
Insoluble	31.4 percent

The property apparently lay dormant until 1966. A prospecting permit was issued to Nada N. Alverich, Roy A. Picchi, and David Iveson of Reno, Nevada, in 1966 which included the property, and other parts of sections. 5, 6, 7, and 8. Some work was done under this permit, but there is no recorded production.

Sano Consolidated Prospect

The Sano Consolidated prospect adjoins the Packard mine on the north and is located in sections 4 and 9, T. 28 N., R. 21 E. In the early 1920's, underground workings consisted of three adits having lengths of 65, 70, and 245 feet, and a 20-foot shaft.

Data in U.S. Geological Survey files at Phoenix indicate the mineralized structures are narrow veins and stringers containing galena in diabase. The structures strike northeast and dip northwest. The largest vein is as much as 3-½ feet wide; most are from 1 to 6 inches wide. A sample from the bottom of the 20-foot-deep shaft on the widest vein contained 0.08 ounce gold and 32.4 ounces silver per ton, and a trace lead. A sample taken by the U.S. Bureau of Mines in the same location assayed 0.08 ounce gold, 10.2 ounces silver per ton, and a trace lead. A sample from a 10-ton stockpile on the dump assayed 0.36 ounce gold, 38.0 ounces silver per ton, and 2.4 percent lead. A sample of the same material taken by the Bureau of Mines assayed 0.26 ounce gold, 8.8 ounce, silver per ton, and 0.70 percent lead. A sample at the face of the 35-foot adit by the Bureau of Mines assayed 0.02 ounce gold, 0.4 ounce silver per ton, and 0.40 percent lead.

The property has apparently been dormant since 1927.

Tungsten

Literature reports no occurrence of tungsten on the reservation. However, 100,000 short-ton units have been produced from several mines in the Nightingale mining district, several miles east, along the boundary between Washoe and Pershing Counties (Bonham, 1969, p. 70). Smith and Guild (1942, p. 39-58) describe the occurrences in detail.

Scheelite, the common ore of tungsten, occurs in the Nightingale district, along a contact zone (tactite) between Mesozoic metasedimentary rocks and biotite-quartz monzonite. These deposits also contain gold, silver, molybdenum, copper, and uranium.

The same geologic environment occurs on the Pyramid Lake Reservation, but tungsten has not been recorded.

Energy Resources

Geothermal

General

Hot springs are often indicative of potential geothermal areas. The Pyramid Lake Reservation contains the following hot springs (Waring, 1965): Ross Spring, T. 28 N., R. 20 E., North Pyramid Lake; Various Springs, T. 28 N., R. 21 E., North Pyramid Lake; Needles area, T. 26 N., R. 20-21 E., northwest shore, Pyramid Lake; Various Springs, T. 27 N., R. 23 E., northwest shore, Winnemucca Lake; Various Springs, T. 26 N., R. 23 E., west shore, Winnemucca Lake; Anaho Island, T. 24 N., R. 22 E. in Pyramid Lake. Only hot springs whose locations are adequately described in the literature are shown on Figure 3.

The "Needles" site at the north end of the lake, and the site near Anaho Island at the southern end of the lake, appear to have the greatest potentials. Both are characterized by sinter crags. The sinter crags are believed to have been formed by geothermal solutions that surfaced along fault lines. The crags have been modified by later calcareous encrustations from windblown deposits of calcium carbonate.

Needles Area

The Needles area is characterized by parallel rows of sinter crags trending northwest along which hot springs occur.

In 1962, Paiute No. 1 well was drilled between the two southernmost "needle rocks" on unsurveyed land, in the southwest corner of sec. 6, T. 26 N., R. 21 E. Initially, between September 23 to October 30, 1962, Western Geothermal Inc. drilled to a depth of 4,200 feet. Later the well was extended to 5,900 feet. Geothermic tests made October 9, 1952, at 100-foot intervals from 600 feet to 2,475 feet showed increasing temperatures from 138°F at 600 feet to 199°F at 2,475 feet. On October 18, the well was blown out with nitrogen at the following intervals: 998 feet, 1,645 feet, 2,525 feet, 2,940 feet. It blew clean hot water and steam, with a temperature of 208°F On October 30, when the well was bottomed at 4,200 feet, the geothermic test was made at 100-foot intervals from 2,020 to 4,180 feet. Temperatures ranged from 179° at 2,020 feet to a maximum of 208°F at the bottom. It was found that the well was less active at its final 5,900-foot depth compared to the 4,200 foot level. Neither flow nor temperature had increased. Western Geothermal, Inc. did not consider the well to have commercial potential.

In the fall of 1976, Paiute No. 1 was geysering with a steam plume visible for miles, with hot water flowing into Pyramid Lake. According to Western Geothermal, Inc., the water contains 4,000 ppm solids and is unsuitable for irrigation.

The Paiute No. 1 well penetrated highly-altered bedrock at about 350 feet. Below this, highly-altered rhyolitic tuffs and andesitic flows of varying degrees of porosity were intersected. No rocks of definite sedimentary origin were found. The drilling did not delineate a strong structural zone.

In 1965, Western Geothermal, Inc. drilled three additional wells in the Needles area. Apache No.

1 on the shore of the lake near the westernmost "Needles" is geysering 150 to 200 gpm steam and water at 200°F. Apache No. 2 is open, and has water about 10 feet from top. Apache No. 3 is closed.

An infrared survey made in 1965 for Western Geothermal, Inc. by Cartwright Aerial Service, in cooperation with the Barnes Corp., indicated that the sinter crags are 10 to 15 degrees hotter than the surrounding flat desert. This is an apparent reversal of the temperature pattern in nearby mountains, which consistently show lower temperatures over exposed rock surfaces, as compared to desert areas (U.S. Geological Survey files, Phoenix).

Anaho Island Area

The Anaho Island area was under prospecting permit to Nevada International Geothermal, Inc. in 1976. Information on work in this area is not available.

Oil and Gas

Of the rocks known to underlie the reservation, most are igneous and, therefore, not typical host rocks for oil and gas. No oil and gas wells have been drilled on the reservation (Lintz, 1957; Schilling and Garside, 1968). The deepest drilling was Paiute No. 1 geothermal well which reached a depth of 5,900 feet in the "Needles" area. No rocks of definite sedimentary origin were encountered.

From published records (Lintz, 1957, p. 45), the nearest oil drilling was about 35 miles southwest of the reservation in SE ¼ sec. 21, T. 19 N., R. 19 E. This well was drilled in 1907 to a depth of 1,890 feet. Shows of oil and gas, which might have come from lacustrine beds, were reported.

Quaternary lake beds of Lake Lahontan have produced gas. According to Lintz (1957, p. 17), the gas was probably formed by bacteria acting upon organic debris entombed in lake mud. Small amounts of gas may be present in the geologically similar playas in the Pyramid Lake, Smoke Creek Desert, and Winnemucca Lake areas.

Uranium

Several permits have been issued for uranium prospecting on the reservation, but no significant discoveries have been reported. However, there have been several small, intermittent uranium producers in the Pyramid mining district which joins the western boundary of the reservation (Figure 1). In the Pyramid district, uranium often occurs along northeast-trending faults in the Hartford Hill rhyolite, or along faulted contacts of younger diabase dikes within the Hartford Hill Formation (Garside, 1973, p. 99). Generally the uranium occurs around the periphery of the district (Bonham, 1969, p. 82, 83). Uranium minerals include autunite, sabugalite, uranospinite, phosphuranylite, and uraniferous opal, chalcedony, and hematite.

In 1960, portions of sections. l, 2, ll, and 12, T. 23 N., R. 23 E., and sections. 26, 27, 28, 33, 34, and 35, T. 24 N., R. 23 E. (just north of Nixon, and on the opposite side of the lake from the Pyramid district), were held under prospecting permit by Pacific Uranium Mines, Grand Junction, Colorado.

Nonmetallic Mineral Resources

Nonmetallic minerals on the reservation include marl, clays, diatomite, limestone, dolomite, and sand and gravel.

Marl (Unconsolidated Calcium Carbonate)

Marl deposits of algal origin are present in the area west and northwest of Pyramid Lake, both on and off the reservation. Papke describes the deposits in detail (Bonham, 1969, p. 108-110). A deposit also occurs on the eastern edge of the Lake Range about 25 miles north of Nixon. The deposits are remnants of a nearly flat-lying bed within a sequence of impure diatomite. The bed was deposited in shallow waters of Pleistocene Lake Lahontan, and occurs at altitudes from 4,080 to 4,100 feet in southern exposures and from 4,100 to 4,120 feet in northern exposures. Deposits were formed in restricted valleys and along gently sloping areas having favorable lake bottoms for the accumulation and preservation of the soft, fresh-water calcium carbonate deposits.

The thickness of the marl bed ranges from a few feet to more than 12. Thickness is dependent, in part, upon the configuration of the lake basin at the time of formation, with the bed thinning near the edges of the basin.

The calcium carbonate is largely from the stems and powdered debris of Chara, a type of bushy, plant-like algae, a few inches tall, that lives in a non-marine environment (Bonham, 1969, p. 109). The calcium carbonate and included gastropods sampled by Broecker and Orr (1958, p. 1009-1032) near Astor Pass (Figure 2), were radiocarbon dated at 16,800+600 and 17,500+600 years, respectively.

Bonham (1969, p. 109) reports the partial chemical analysis of four samples of unconsolidated calcium carbonate from the vicinity of Pyramid Lake that average:

CaO	36.80 percent
MgO	1.02 percent
SiO	21.52 percent
A12O3	4.15 percent
SO3	2.50 percent
H20	2.29 percent

The reservation's deposits have been mined intermittently for many years. In 1938, there were 11 active leases. Production has been small, only a few hundreds of tons per year, except during the period 1945 through 1949 when as much as 10,000 tons per year were mined, mostly from sections 15 and 16, T. 24 N., R. 21 E., about a mile west of Sutcliffe. In the fall of 1976 there were no leases for marl in effect on the reservation.

The marl was used primarily as fertilizer and soil additives whose largest market was in the Sacramento Valley in California. It was also used as an additive to poultry and livestock feeds.

According to Bonham (1969, p. 110), there are large tonnages of marl with more than 60 percent calcium carbonate available both on and near the reservation.

Clays

Halloysite

Halloysite clay deposits occur both on and west of the reservation in the Terraced Hills to the north. A good description of the deposits is given by Papke in Bonham's (1969, p. 110-113) report on Washoe and Storey Counties.

Halloysite is a hydrous, aluminum silicate resembling kaolinite, but amorphous, and contains more water. It is used in whitewares, in refractory ceramic products, and is a potential source of alumina for aluminum. Its use is restricted when contaminated with iron, which is the case with many of the Terraced Hills occurrences.

In 1962, E. L. Stephenson (1966b, p. 1) investigated the Terraced Hills clay deposits for A. J. Anderson of Reno, Nevada, who had the prospecting permit. According to Stephenson, widely distributed outcrops of clay are in T. 27 N. and 28 N., R. 20 E., suggesting essentially flat-lying beds in a volcanic sequence that include both basalt and andesite. No exposure shows more than one clay zone, and the similarity of outcrops suggests they may represent a single zone. The clay zone ranges from 30 to more than 100 feet thick.

The clay varies in color from off-white through shades of gray, gray-brown, buff, tan, brown, and red. Several color variations may occur within a single exposure.

Stephenson (1966b, p. 2) reports chemical analyses of 21 clay samples. Most were channel samples, but a few were grab samples from relatively small outcrops. The A12O3 content ranged from 30.21 to 38.53 percent and averaged 34.32 percent. Silica averaged 38.76 percent. The iron content ranged from 7 to 14 percent in the more highly colored varieties, but was much lower in the lighter varieties. The latter usually contained higher alumina and silica. Alkali content was generally low.

If the iron content can be economically reduced, the clays with high alumina have a potential for use in the manufacture of aluminum. Because of their wide areal extent, the clays should be further investigated.

No tests are known to have been made to determine if the clays are suitable for refractory ceramic products. Where the iron-oxide content is high, clays fire dark red to brown, and these are not usually desirable colors. While selective mining of low-iron clays is a possibility, the great distance from markets (San Francisco Bay area) probably precludes, for the present, any economic potential for the reservation's clays.

The Nevada Cement Co. is presently mining high alumina clay for use in cement, just west of the reservation in sec. 13, T. 27 N., R. 19 E. The plant is near Fernley, south of the reservation. This clay reportedly averages about 31 percent A12O3 (U.S. Geological Survey files, Phoenix, Arizona).

Montmorillonite (Bentonite)

A deposit of montmorillonite (bentonite) clay occurs several hundred feet west of the highway on the reservation in the E. ½ sec. 3, T. 23 N., R. 23 E., and SW ¼ sec. 27, E ½ sec. 33, and in sec. 34, T. 24 N., R. 23 E. (Papke, 1970, p. 40). This site is approximately 6.5 miles north of Nixon, via State Highway 34.

In 1960, Don S. York, operating under a prospecting permit, rotary drilled 19 holes in an area about 1,800 feet long and 400 feet wide, just west of the highway. The area is covered by about 7 feet of alluvium (generally sand), and there are no clay outcrops. Twelve holes penetrated the clay which had intercept lengths ranging from 9 to 24 feet, averaging 16. The drilling was terminated because of wet conditions before any holes reached the bottom of the montmorillonite clay. According to Papke (1970, p. 40), montmorillonite was the only identified clay mineral. Potassium feldspar, cristobalite, quartz, plagioclase, and volcanic glass were also found.

Papke (1970) gives detailed test data of four samples from the deposit. Swelling ranged from 160 to 750 percent. Data in the U.S. Geological Survey files in Phoenix show that other samples from this locality swelled between 400 and 1,200 percent in comparison to 1,700 to 1,800 percent for Wyoming bentonite, the industry standard. These tests may have discouraged development of the deposit.

Montmorillonite, especially that containing trace elements, has been used as a soil additive. It may also be useful locally for lining canals and reservoirs to prevent water seepage.

Diatomite

Diatomite occurs a few miles east of the reservation in T. 23 N., R. 24 E., sections 2, 3, 4, 8, 9, 10, and 11, on the north side of the valley and in sections 21, 22, on the south side (Bonham, 1969, p. 117-118). In sec. 8, the total exposed thickness is 145 feet in Pliocene strata. West of the western reservation boundary, in sections 3 and 4, T. 23 N., R. 21 E., it is exposed in several shallow pits and trenches in the Middle Miocene, Pyramid Formation.

The diatomite-bearing strata extend into the reservation. Prospecting might disclose diatomite on the reservation.

Impure diatomite is also associated with the marl deposits along the west side of the reservation. Both of these materials were deposited in shallow waters of Pleistocene Lake Lahontan (Bonham, 1969, p. 109).

Large deposits elsewhere in Nevada, and the low quality of the known diatomite near the reservation, are factors which lower the potentials of these deposits.

Limestone and Dolomite

The Marble Bluff limestone and dolomite deposit is about 3-½ miles north of Nixon, and is crossed by State Highway 34. The principal occurrence is in sec. 10; however, limestone has recently been mined for riprap from sections 9 and 15, T. 23 N., R. 23 E.

Marble Bluff is a mountainous inlier of marine limestone and dolomite considered by Stephenson (1966a, p. 49) of probable Triassic age. It is completely surrounded by valley fill and Tertiary volcanic rocks. The area of exposed limestone and dolomite is about 2 square miles. Elevations range from 3,900 feet in the valleys to over 4,500 feet on the crest of the main ridge. The middle and lower slopes are covered by a persistent coating of calcareous tufa formed in ancient Lake Lahontan.

According to Stephenson (1966a, p. 49), the limestone appears to be stratigraphically lower than most of the dolomite; it is massive, finely-crystalline, gray to blue-gray, and weathers to typically smooth and satiny surfaces. It has been metamorphosed and, in places, grades into white, or nearly white, marble.

The dolomite, which is more variable in texture and appearance, is a thinly-bedded to massive, dark blue-gray to blue-black or black rock that weathers to typically fluted and roughened surfaces with a graphic appearance.

In 1962, six holes were diamond drilled in sections 9 and 10, T. 23 N., R. 23 E., to determine if the west bench on Marble Bluff contained sufficient limestone suitable for use in the manufacture of cement at the Nevada Cement Co. plant. The plant is 22 miles south of the deposit by road. According to Stephenson (1962, p. 9), the block of limestone and marble most accessible to the main highway contained insufficient reserves for a cement plant. Although some holes intercepted good grade limestone, complex folding and faulting caused an intermixing of limestone and dolomite.

Stephenson (1966a, p. 49-50) believes there is a large tonnage of limestone in the central part of Marble Bluff, estimates that the largest limestone block contains 112,000,000 tons. It consists of more than 95 percent calcium carbonate and has a low magnesia and alkali content.

Earlier Nevada Cement Co. leased the Marble Bluff deposit, but it was not under lease in the fall of 1976. Presently Nevada Cement Co. obtains limestone off the reservation from the Fernley deposit 4 miles south of Fernley, on the northeast flank of the Virginia Range.

Sand and Gravel

Extensive sand and gravel deposits are in the terraces of the Truckee River at the southern end of Pyramid Lake. A number of them have been mined in T. 24 N., R. 21 E., in the Wadsworth area in recent years. Production from sections 33 and 34 has amounted to over 150,000 tons. Proximity to the Reno area, where local sand and gravel deposits are being depleted, should make them more attractive.

In the mid-1960's, a small amount of gravel was taken from sec. 36, T. 24 N., R. 21 E., reportedly about 4 miles south of Sutcliffe (U.S. Geological Survey files, Phoenix). It did not meet State and Federal specifications for cement and the operation was abandoned. This gravel is outwash material from the Virginia Mountains.

A large gravel deposit in the northwestern part of the reservation, is in the southwest corner of T. 28 N., R. 20 E., is crossed at Sand Pass by the Western Pacific Railroad. Although the railroad has removed large tonnages, significant reserves remain.

Depletion of sand and gravel reserves in the Reno and Sparks areas will allow reservation deposits to become economically competitive, although the market is 32 miles away.

TRANSPORTATION

The Pyramid Lake Indian Reservation is served by both rail and highways. The Western Pacific

Railroad crosses the northwest corner of the reservation, and the Southern Pacific Railroad the south tip, near Wadsworth. Until 1971 (when the track was removed), the Southern Pacific followed the west shore of Pyramid Lake and joined the Western Pacific Railroad just west of the reservation at Flanigan. The right-of-way for this section has reverted to the reservation.

U.S. Highway 50 crosses the south end of the reservation and provides access to Reno, 32 miles to the west. State Highways 33 and 34 provide access to the reservation's western and eastern sections.

EXPLORATION ACTIVITY

In December 1976, there were two geothermal leases covering the Needles and the Anaho Island area, and a sand and gravel lease of 30 acres in the NE ¼ sec. 33, T. 21 N., R. 24 E., near Wadsworth.

RECOMMENDATIONS FOR FURTHER STUDY

Because of the incomplete knowledge of the geology of the Pyramid Lake Indian Reservation, the mineral potential of the area is difficult to appraise. A more comprehensive study of the potential mineral resources should include the following:

1. Geologic mapping of the reservation at a scale of 1:62,500 or 1:24,000. Particular emphasis should be placed on outlining areas of hydrothermal alteration, intrusive rocks, and fault and fracture zones, and areas with a high potential for nonmetallic deposits.

2. Detailed geologic study of all known mineral occurrences.

3. Application of geochemical prospecting techniques, including sampling of fracture fillings, veins, soils and stream sediments, tactites, and mafic intrusive rocks.

4. Evaluation of hydrothermally altered rocks, including petrographic and X-ray techniques to determine alteration mineral assemblages, and, thus, the type and intensity of the alteration.

5. Geophysical surveys.

6. Trenching and core drilling, where warranted, as determined by other techniques.

7. Testing of the known clay deposits.

Those localities that appear to be the most promising exploration targets are:

1. The margins of granodiorite intrusive bodies in the Fox Range, where quartz veins may contain silver, lead, and gold, and tactite beds may contain tungsten.

2. Fractures and faults in the Hartford Hill Rhyolite Tuff in the Mullen Pass area. Uranium minerals in the adjacent Pyramid district occur in bleached and locally silicified zones along faults which are commonly localized along diabase dikes.

3. The Guanomi mine area, where molybdenum and copper in hydrothermally altered quartz monzonite suggest a porphyry-type deposit. Although the intrusive body recently has been explored by several drill holes, more exploration is needed to determine whether copper and molybdenum are present in economic concentrations.

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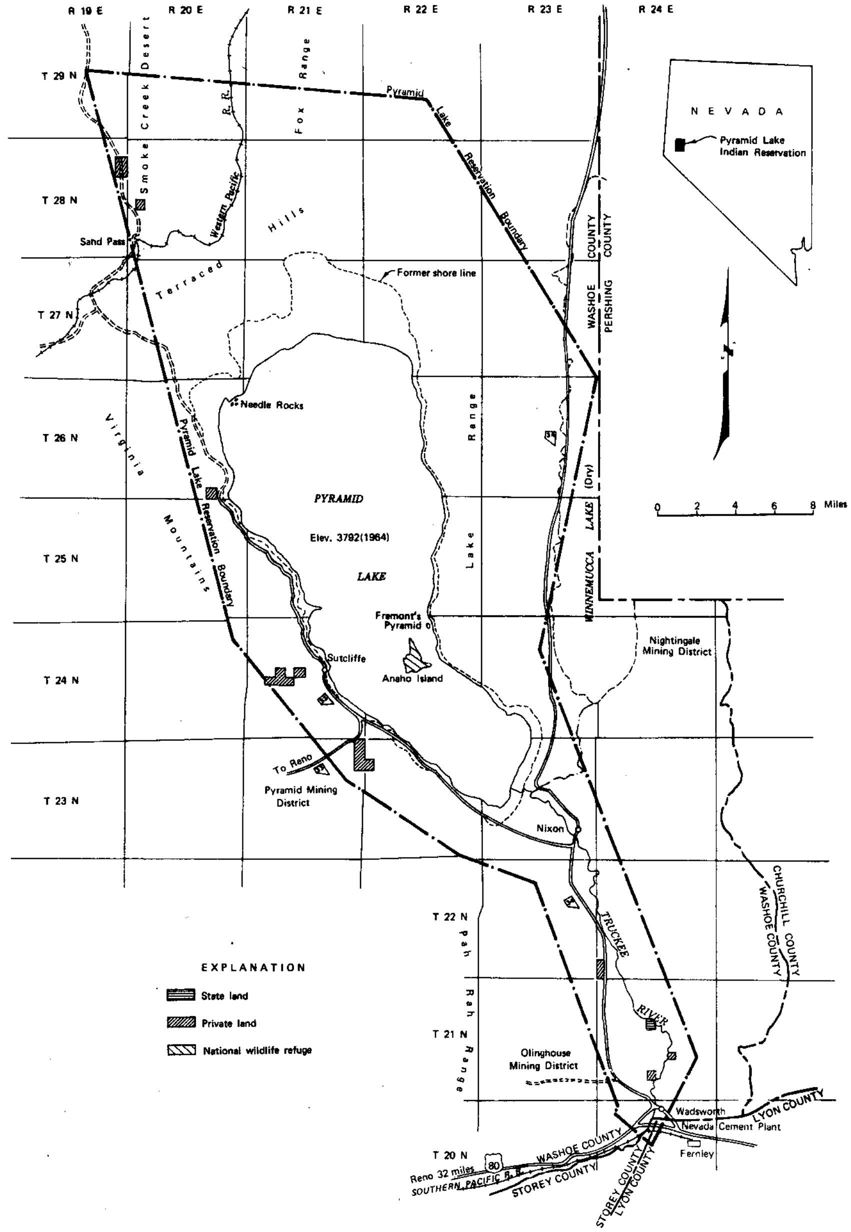

Figure 1. Index map of the Pyramid Lake Indian Reservation.

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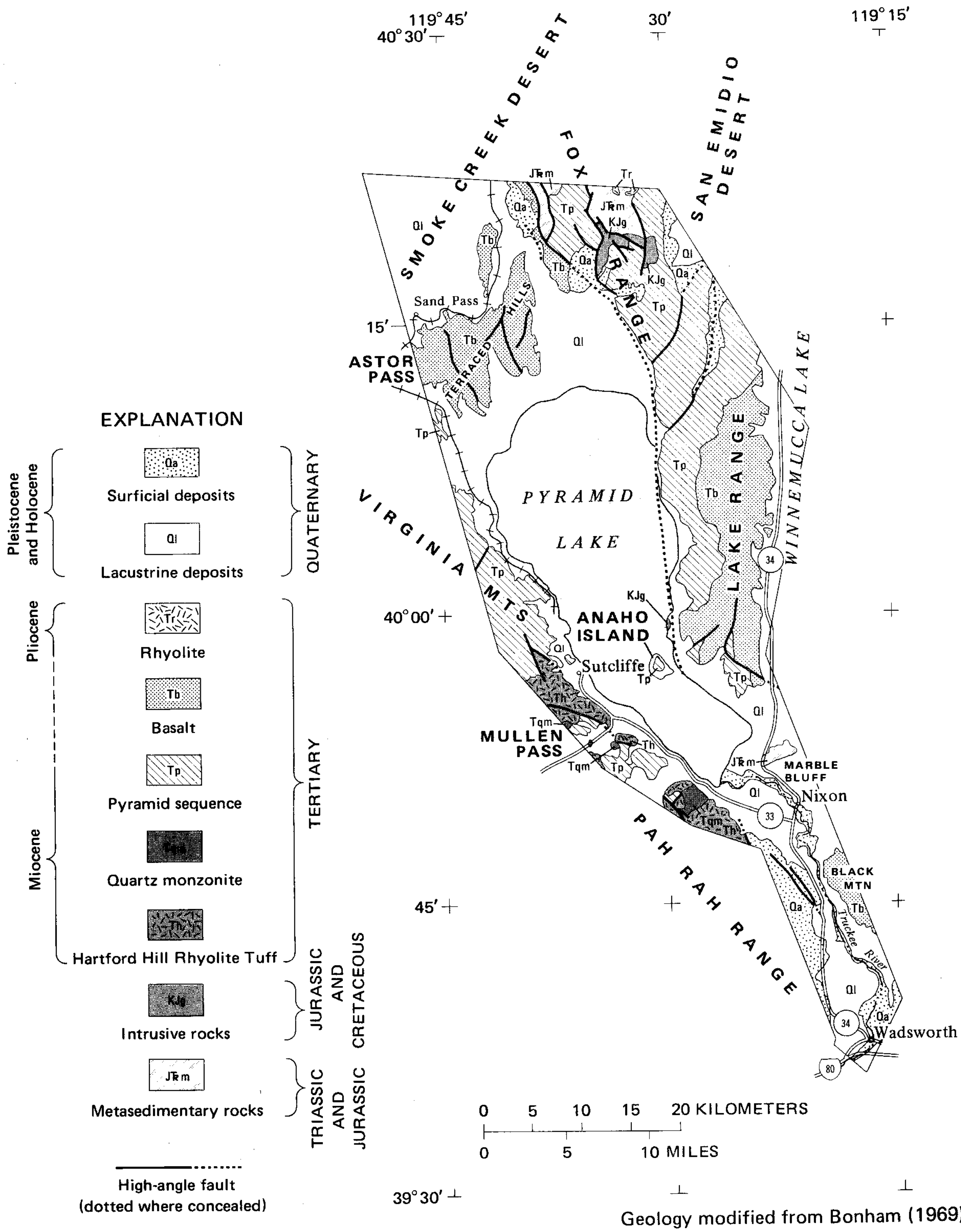

Figure 2. Geologic map of the Pyramid Lake Indian Reservation, Nevada.

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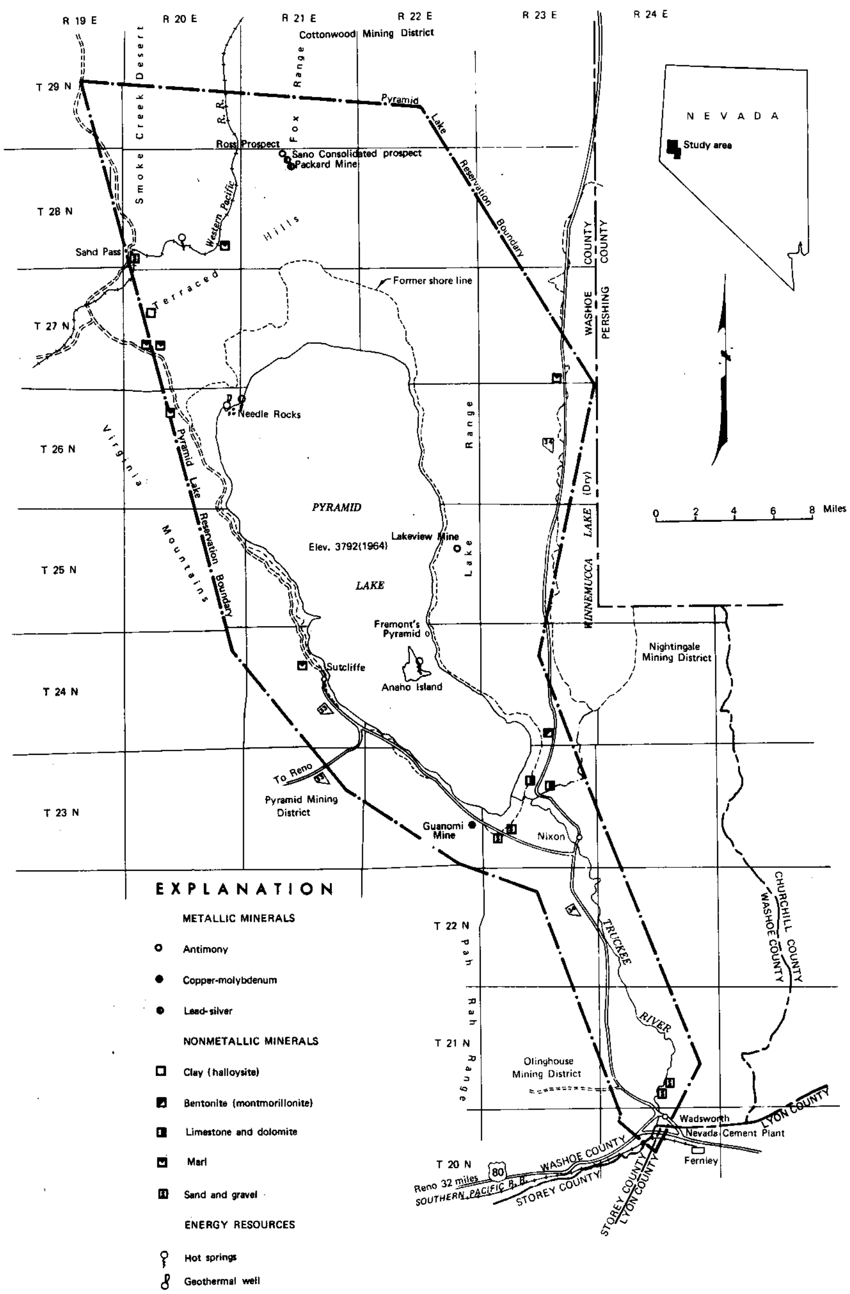

Figure 3. Map showing location of mineral deposits on the Pyramid Lake Indian Reservation, Nevada.

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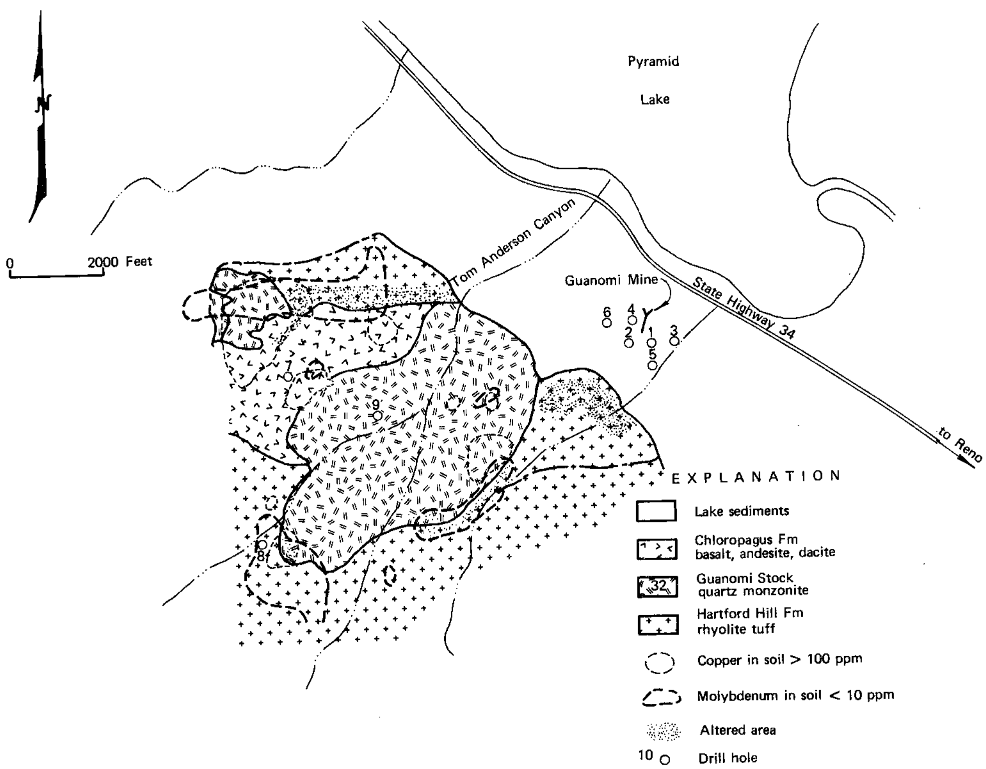

Figure 4. Simplified geologic and geochemical map showing location of drill holes, Guanomi mine area, Pyramid Lake Indian Reservation, Nevada.

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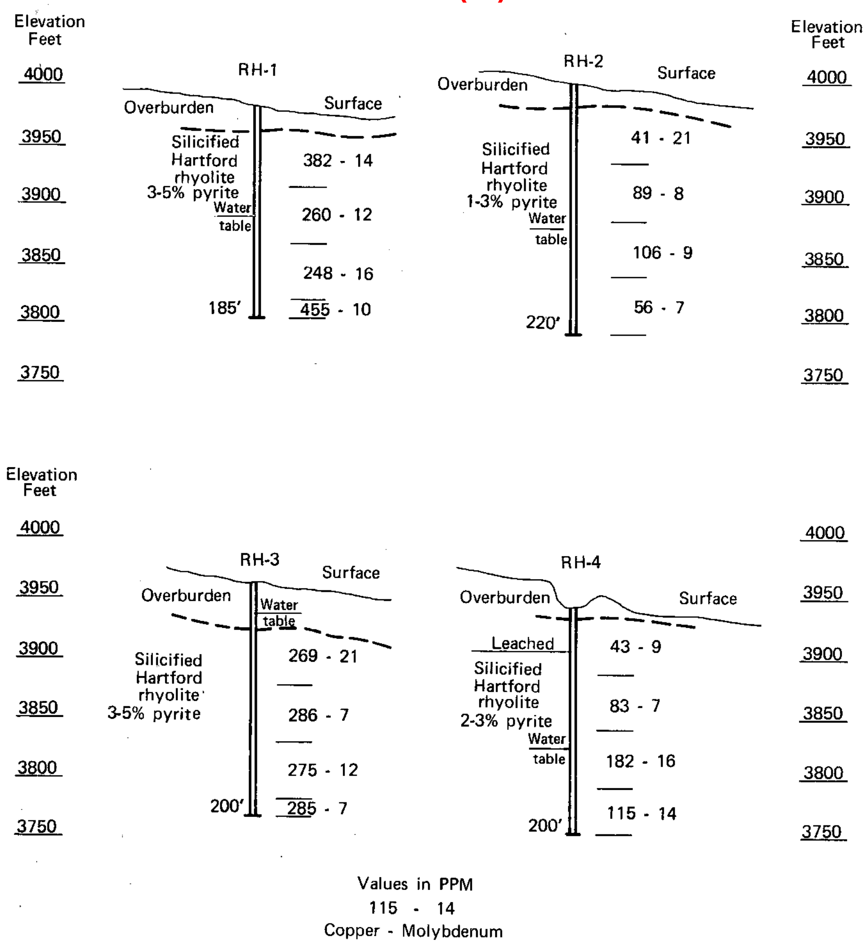

Figure 5. Sections through rotary drill holes 1 through 4, Guanomi mine area.

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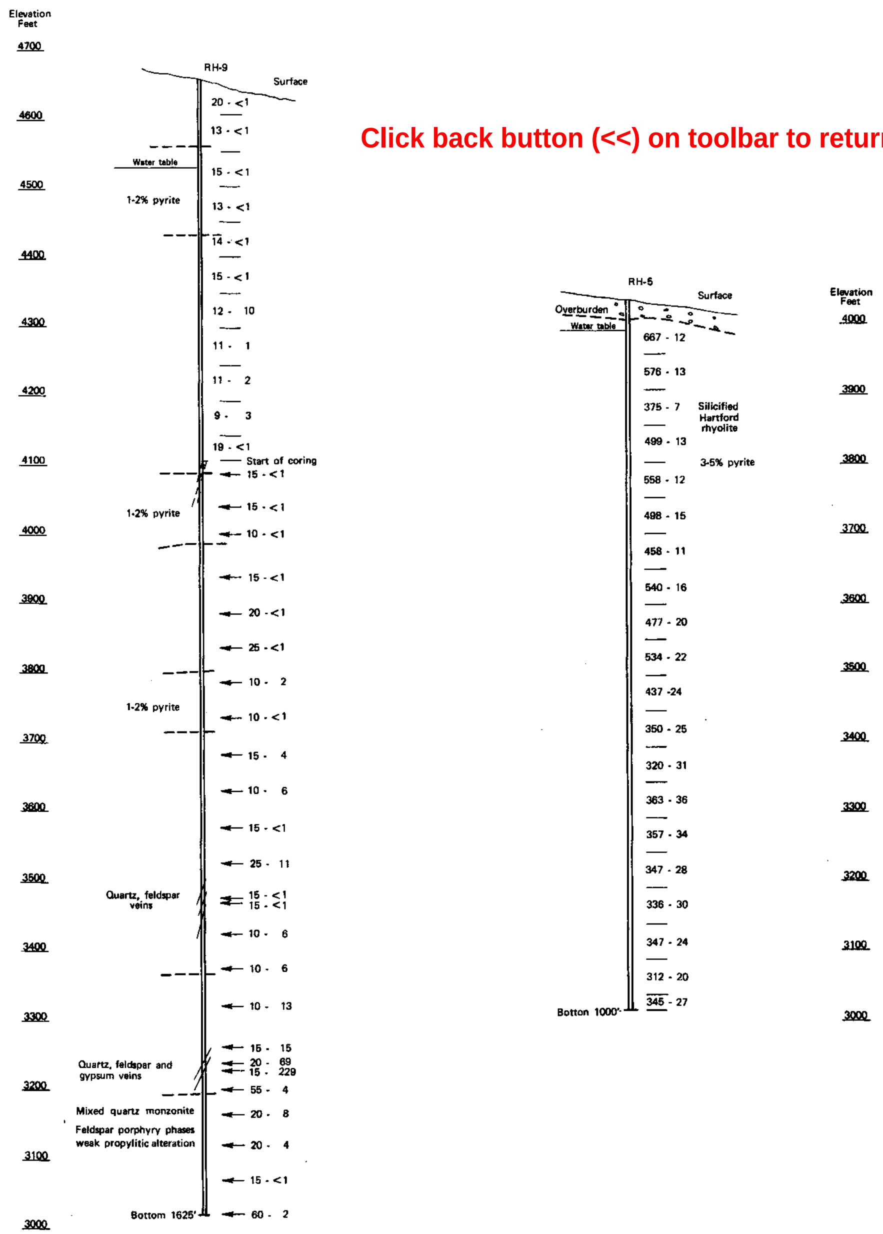

Figure 6. Sections through drill holes 5 and 9, Guanomi mine area.

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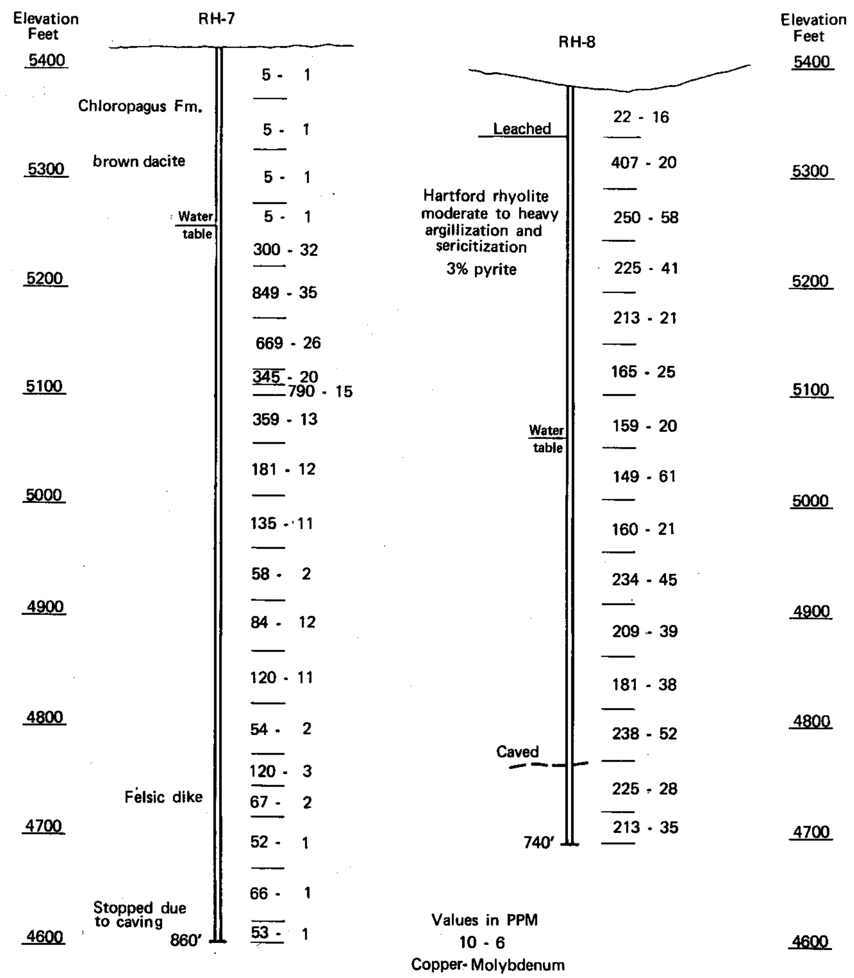

Figure 7. Sections through rotary drill holes 7 and 8, Guanomi mine area.

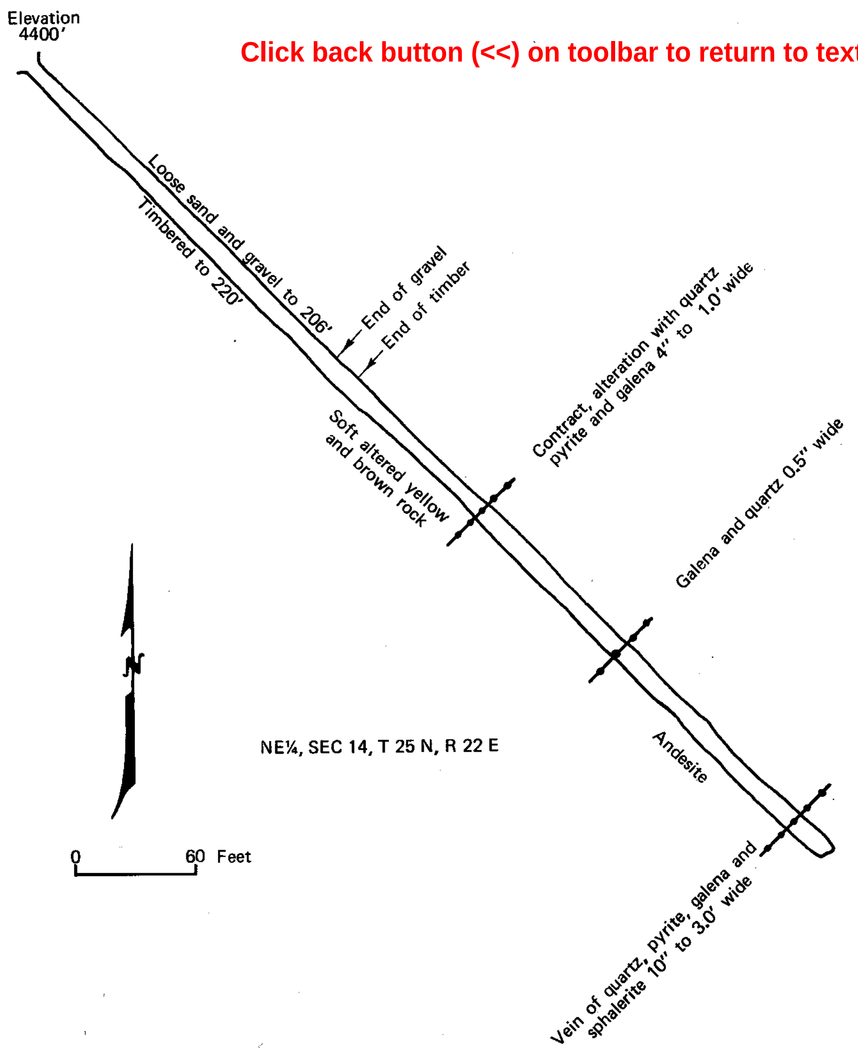

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Figure 8. Plan map of Lakeview mine crosscut, Pyramid Lake Indian Reservation, Nevada.

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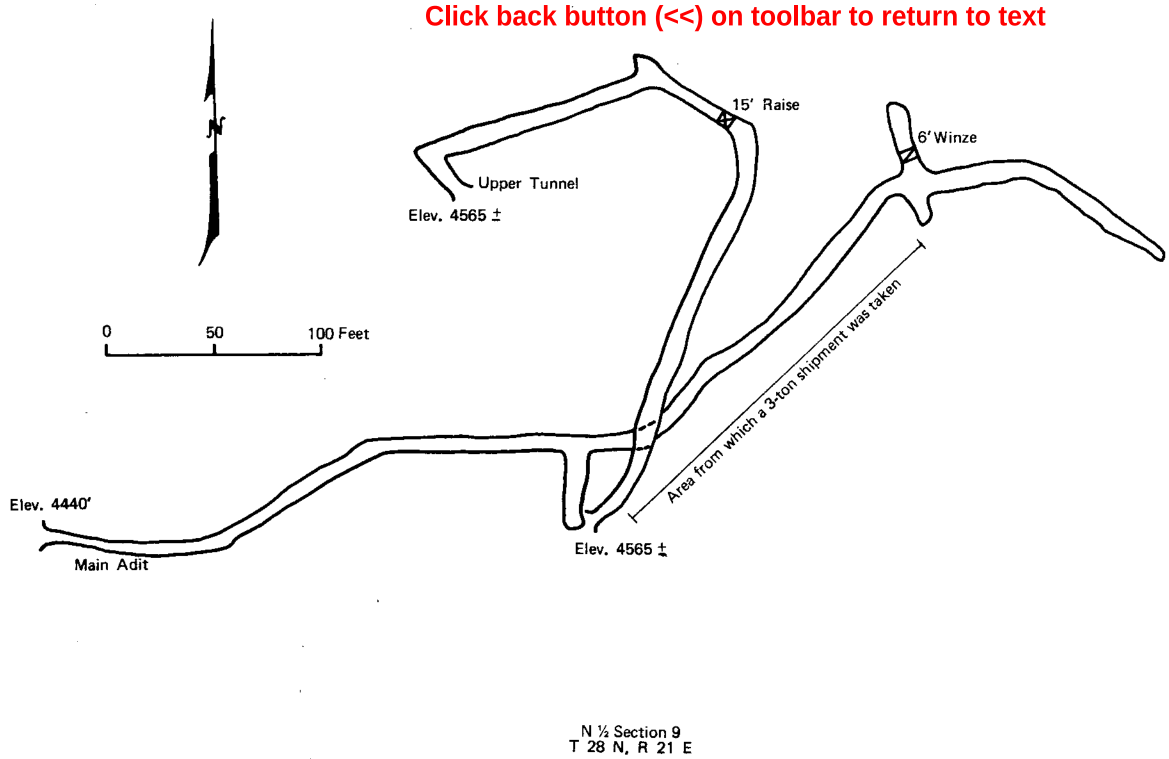

Figure 9. Plan map of main underground workings Packard mine, Pyramid Lake Indian Reservation.